PERFORMANCE AND EMISSION CHARACTERISTICS OF ALCOHOL FUEL BLENDS WITH FUEL IONIZATION ON SINGLE CYLINDER DIESEL ENGINE

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Abstract:

Fossil fuels are widely used in the world so the resources are being depleted day by day so there is a need to find out an alternative fuel to fulfil the energy demand of the world.Alcohols are considered as one of the suitable fuel substitution for diesel engines because it allows the diesel fuel to enhance the burning due to presence of more oxygen, which improves engine characteristics. . Methanol, ethanol and butanol are the alcohols, which attract the attention of most of the researchers recently because of their ease of availability, but I have selected butanol as my alternative fuel due to its properties nearer to diesel fuel.

The fuel magnetization on the performance of diesel engine. It has been observed that on magnetization viscosity of hydrocarbon fuel decreases due to declustering of the Hydrocarbon fuel molecules which results in better atomization of the fuel and efficient combustion of air fuel mixture. This enhances thermal efficiency and improves the fuel economy of I.C engine. The magnetic field applied along the fuel line immediately before fuel injector. The magnetic field of different intensity of 2000gauss and 5000gauss is applied with the help of permanent magnet and its effect on fuel consumption as well as on exhaust gas emission will be studied and compared with performance without application of magnetic field. At different load conditions the experiments are conducted to analyses the fuel consumption, thermal efficiency and exhaust gas analyzer is used to measure the exhaust gas emission.

Key**words- Diesel engine, Performance and Emission characteristics, Magnetic Induction, Butanol.**

I. INTRODUCTION:

Diesel engines, particularly direct injection types, have been an important choice as prime movers in heavy-duty applications such as on-road, off-road, marine and industrial usage due to their high brake thermal efficiency.Diesel engines are low speed high torque engines, suitable for hauling loads in trucks. They have high backup torque unlike gasoline engines and thus eliminating need of frequent gear changes when used in automobile applications. Over the past few decades there is more concern growing on developing alternative fuels for reducing the dependency on the petroleum products, to reach the growing emission standards and to increase the thermal efficiency.Many research programs are going on for developing the alternative fuels like biodiesel, alcohol fuel, methane, compressed natural gas, liquid petroleum gas, di methyl ether, water coal slurry and many other fuels. Among all this fuels Biodiesel and alcohol fuels make easier to use in IC engines because of their liquid state and some properties of the fuel are very similar to the diesel fuel. Alcohol fuels shows a some advantages over biodiesel in terms of

Viscosity, rich oxygen content and less corrosion than biodiesel.There are many researches going on different type alcohol fuels such as Methanol, Ethanol, Propanol and Butanol. Butanol is a one type of alcohol fuel with a molecular structure of C4H9OH and is a higher chain alcohol when compared to ethanol and methanol. Butanol shows some properties better than other alcohol fuels.

Properties	Ethanol C2H5OH	n-Butanol C4H9OH	Low-sulfur automotive diesel fuel
Density/15oC(kg/m3)	789	810	820-850
Kinematic viscosity/40oC (cSt)	1.20	2.5	2-3.5
Cetane-number	5–8	25	50
Lower heating value (kJ/kg)	26800	33000	43000
Carbon content C (% weight)	52.2	64.8	84-87
Hydrogen content H (% weight)	13.1	13.5	13-16
Oxygen content O (% weight)	34.7	21.6	0
Latent heat of evaporation (kJ/kg)	900	585	265
Boiling temperature (oC)	78	118	180–360
Lubricity (μm)	950	590	310
Flammability limits (% vol.)	3.3−19	1.4−11.2	1.5−7.6
Flash point (oC)	13	35	50-90

Table:1 Comparing properties of Ethanol, n-Butanol and Diesel fuel (7).

Number of experiments in which influence of magnetic field with 1000 Gauss to 9000 Gauss intensity on working of IC engine and exhaust emission was studied for analysis. They reported that a considerable reduction in the hydrocarbon constituent and particulate matter of the exhaust. Experiments were conducted on two stroke gasoline engine with providing magnets of different intensities (2000,4000, 6000 and 9000 Gauss) [Shweta Jain et al. 2012]. The overall performance and exhaust emission tests showed a good result, where the rate of reduction in gasoline consumption ranged between (-1) %, and the higher the value of a reduction in the rate of 1% was obtained using field intensity 6000 Gauss as well as the intensity 9000 Gauss. It was found that the percentages of exhaust gas components (CO, HC) were decreased by 30%, 40% respectively, but CO2 percentage increased up to 10%. The ionization fuel also helps to dissolve the carbon build-up in carburettor, jets, fuel injector and combustion chamber, thereby keeping the engines clear condition(2). The ionization and realignment is achieved through the application of magnetic field, as said by Paul (1993), Park K et al (1997) (1).Many of experimental studies which present evidences of the benefits of magnetic treatment were occurred. For motor vehicles and industrial boilers, much fuel economy and noticeable soot suppressions could be approached when the magnetic treatment was introduced(3).

II. Materials and Methods

Specification of the magnet*:* The NbFeb magnets are avilable in different size and shapes. For this project I have used rectangular bar magnet because these type of magnets are suitable for fuel ionization technique and these can be easily installed on the fuel pipe line before the injector. In general the preferred range of magnetic flux density is from 1000-5000 gauss so I preferred a pair of one low strength magnet 2000gauss and high strength magnet 5000gauss magnet so that comparison of working can be done easily.

Dimensions of the 5000gauss magnet:50*20*06 (in MM)

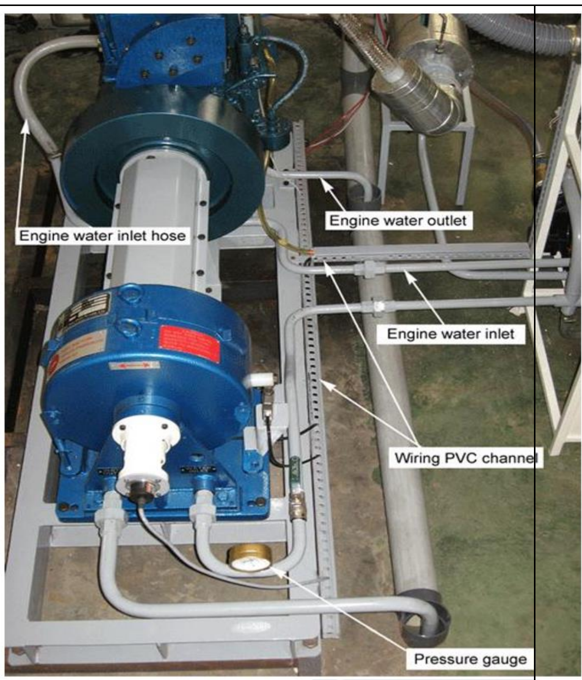
Dimensions of the 2000gauss magnet: 50*20*02(in MM)

Preparation of blend

Three different types of blends are tested in this experiment namely B5(95%diesel, 5%butanol), B10(90%diesel,10%butanol), B15(85%diesel,15%butanol) these blends doesn't need any type of special process because butanol can be blended in diesel up to 35%. Measured volumes of diesel and butanol are taken these fuels can be directly added to the fuel tank.

Engine specifications

The engine specifications are given in table2.The experiment apparatus of the engine under study was a "kirloskar" made single cylinder, vertical four stroke, water-cooled, naturally aspirated, direct injection diesel engine with a bowl-shaped piston surface geometry. The engine shaft was coupled with an eddy current type dynamometer to load the engine. It is provided with necessary instruments for combustion pressure, crank-angle, air flow, fuel flow, temperatures and load measurements.An exhaust gas is an instrument which is used to measure the amount of carbon monoxide among other gases in the exhaust, due to the incomplete combustion. Analysis of



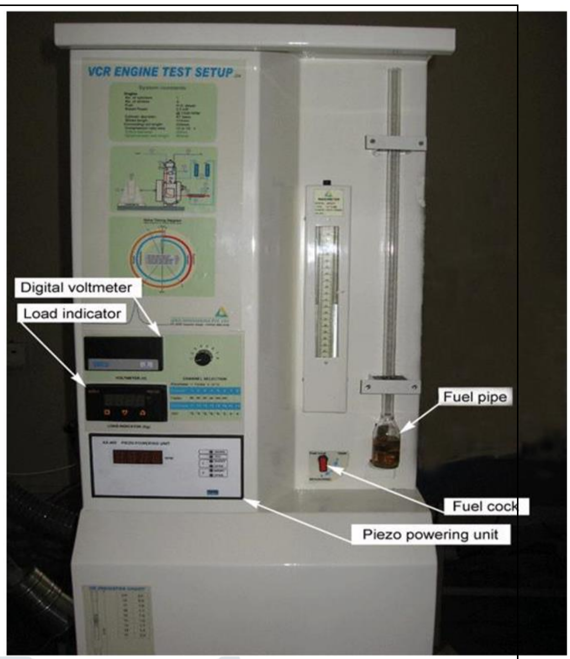


Fig 1 :Engine **Fig 2 :Control panel**

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exhaust gas from combustion engines can help evaluate engine performance and diagnose problems. An engine exhaust gas analyzer can measure Oxygen (O2), Carbon Monoxide (CO), Carbon Dioxide (CO2), Nitrogen Oxide (NO), Nitrogen Dioxide (NO2), and Hydrocarbons (HC's). The principles used for CO sensors are infrared gas sensors (NDIR) and chemical gas sensors.

Product	Engine test setup 1 cylinder, 4 stroke, Diesel with EGR (Computerized)
Product code	234
Engine	Make Kirloskar, Type 1 cylinder, 4 stroke Diesel, water cooled, power 3.5 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm. 661 cc, CR 17.5, Modified to VCR engine CR range 12 to 18
Dynamometer	Type eddy current, water cooled
Propeller shaft	With universal joints
Air box	M S fabricated with orifice meter and manometer
Fuel tank	Capacity 15 lit with glass fuel metering column
Calorimeter	Type Pipe in pipe
EGR	Water cooled, ss 304, Range 0-15

Table 2: Engine specifications

ORIENTATION OF MAGNETS:

The pair of magnets should be placed on the exterior fuel pipe line before fuel injector. A typical size for these magnets adapted for fuel line use is about two inches (5 cm) long and about one half 65 inch (1.25 cm) wide. The south pole S is marked for orientation downstream in the flow path and these two magnets should be placed diametrically opposite in direction.

III. RESULTS AND DISCUSSIONS

BRAKE THERMAL EFFICIENCY:

The brake thermal efficiency increases with the increase in brake power for all the fuels with/without magnetic induction can observe in fig 3. In absence of magnetic induction the brake thermal efficiency of alcohol fuel blends are greater than diesel fuel this is because Butanol can be added as an additive to the fuel and it consists of an oxygen content with in it so all this combine effect will increases the combustion efficiency. Further with the usage of magnetic induction it will decrease the density of the fuel by DE clustering the high fuel molecule this effect makes the fuel easy to participate in combustion, which leads to increase in the brake thermal efficiency. It can be observed from the graph that with in the absence of magnetic induction the blend B15 shows the high brake thermal efficiency 24.01% that is greater than diesel fuel that is 22%. On application of magnetic field the thermal efficiency of the all the blends of the fuel and diesel fuel increases which ranges from 0.2-0.9%. The blend B15 with 5000gauss magnetic induction gives higher brake thermal efficiency 24.36%. This is because in general butanol is added as an additive for improving combustion on the top of it magnetic induction of 5000gauss magnet is applied that makes the engine to yield high brake thermal efficiency, which is 2.36% greater than diesel fuel.

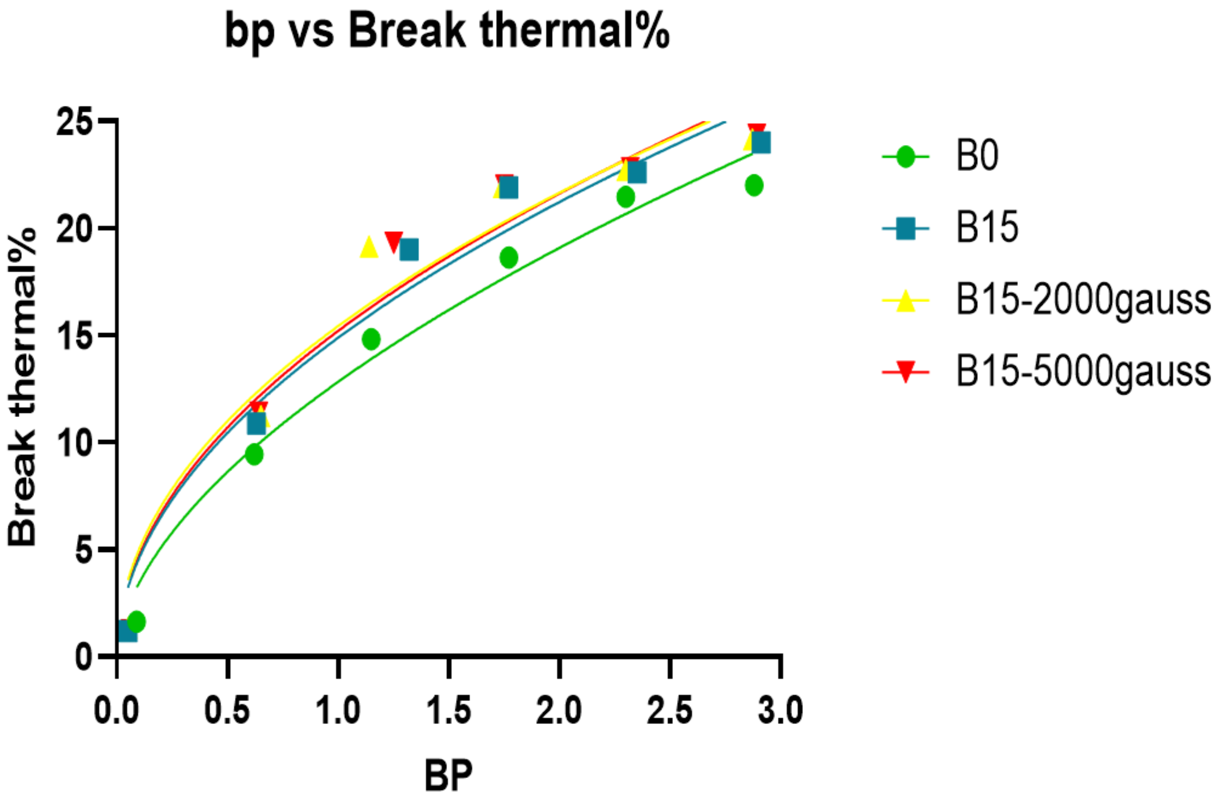

Fig 3 Brake thermal efficiency of the B15 blend

SPECIFIC FUEL CONSUMPTION:

The variation of the specific fuel consumption with the brake power can seen in the fig 4. It can be observed from the figure the specific fuel consumption same trend is followed for diesel and all fuel blends with/without magnetic induction. From graphs it can be observed that at full loads the specific fuel consumption for all the blends of fuel with/without magnetic induction are similar but at the partial loads specific fuel consumption for all blends with/without magnetic induction are less when compared to the diesel fuel. For the engine, running on the diesel the specific fuel consumption is 0.38kg/kWh and blend B15 with 5000gauss magnetic induction specific fuel consumption at full load is 0.35kg/KWh.

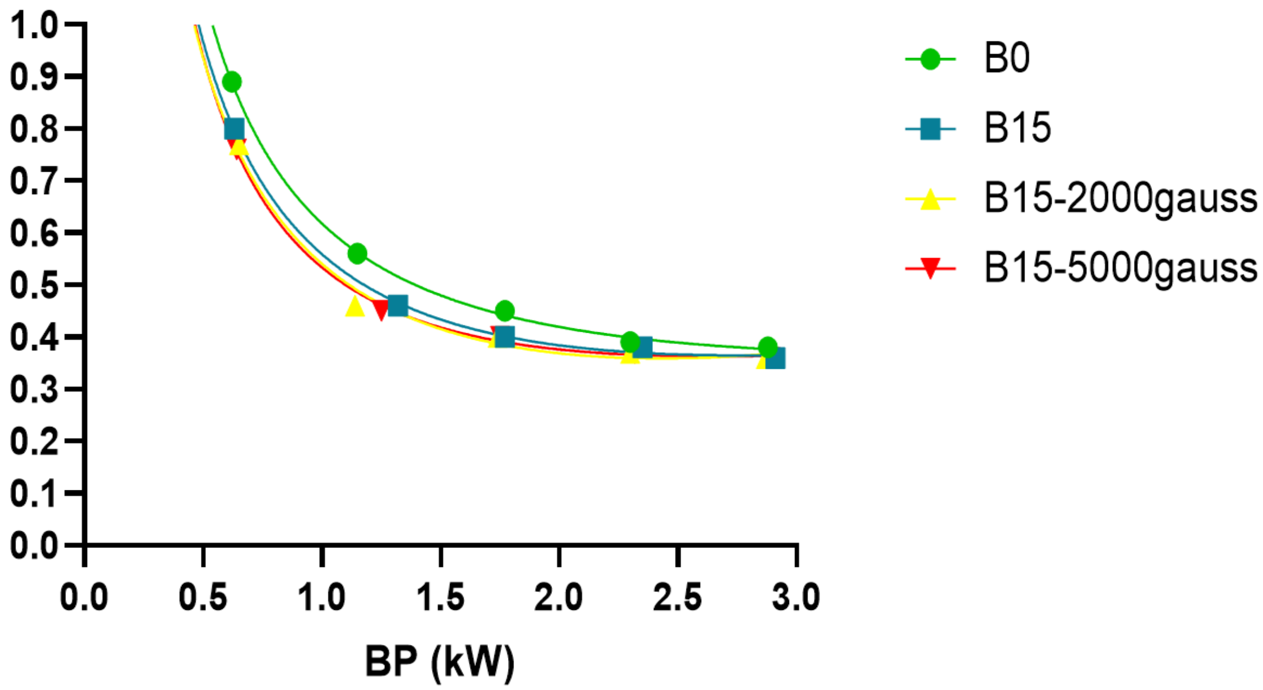

Fig 4: Specific fuel consumption of the B15 blend

EMISSION ANALYSIS

CARBON MONOXIDE (CO) EMISSION:

The CO emission is due to the incomplete combustion of fuel air mixture in the combustion chamber because of insufficient amount of air in the air-fuel mixture or insufficient time or heat in the cycle for the completion of combustion (8). Generally, the compression ignition engines give low CO emissions as they operate with a lean mixture. The CO emission in a CI engine isquite negligible compared to that of SI engines. The alcohol blend will decrease the carbon monoxide emissions due to the oxygen content in the fuel that improves better oxygen availability in the air-fuel mixture. When the magnetic induction is applied to the engine, it enhances air-fuel mixing capability with in the engine that will decreases the carbon monoxide emissions. On combination of these two effects, the carbon monoxide emissions are further decreased as shown in the table 5.3. In this experiment Blend B15 with both 2000 and 5000gauss, magnetic induction shows better emission characteristics when compared to diesel.

Fuel With/without magnetic induction	CO emissions at peak load when compared to diesel	CO emissions at 50% load when compared to diesel
Diesel-2000gauss	Decreased by 10%	Decreased by 10%
Diesel-5000gauss	Decreased by 10%	Decreased by 20%
B5	Decreased by 20%	Decreased by 20%
B5-2000gauss	Decreased by 20%	Decreased by 30%
B5-5000gauss	Decreased by 20%	Decreased by 30%
B10	No change	Increased by 20%
B10-2000gauss	Decreased by 20%	Increased by 10%
B10-5000gauss	Decreased by 30%	Increased by 10%
B15	Decreased by 20%	Decreased by 20%
B15-2000gauss	Decreased by 30%	Decreased by 20%
B15-5000gauss	Decreased by 30%	Decreased by 20%

Table 3:Comparison of CO emissions for all blends

HYDROCARBON (HC) EMISSION:

The unburnt hydrocarbon emission is the direct result of incomplete combustion, due to the incomplete mixing of the air and fuel (8). The variation of the hydrocarbon (HC) emission for the alcohol fuel and diesel with/without magnetic induction are portrayed in table 5.4. The butanol blend B5 generally used as a combustion improver for low cetane number fuel that will increase the combustion efficiency of the engine. Butanol blends due to their oxygen percentage increase the oxygen availability with in the air-fuel mixture, which will reduces the hydrocarbon emissions when compared to diesel engine. When the comparison done between 100% and 50% loads HC emissions will be more In partial loads this is because when the engine running at low loads the temperature inside the engine will not maintain as high as the engine running at full load due to this temperature effect the HC emissions are more in partially loads. On the application of magnetic induction, the HC emissions are further decreased due to improvement in mixing ability of fuel and combustion duration increases for all the fuel blends. The increase in combustion duration maintains the heat for the long time with in the engine this will makes HC emissions to come down on application of magnetic induction. The butanol blend B10 with 5000gauss will show the best result indicating that combustion is improved when compared to diesel.

Fuel With/without magnetic induction	HC emissions at peak load when compared to diesel	HC emissions at 50% load when compared to diesel
Diesel-2000gauss	Decreases by 5%	Decreases by 35%
Diesel-5000gauss	Decreases by 22%	Decreases by 30%
B5	Decreased by 17.64%	No change
B5-2000gauss	Decreased by 33.82%	Decreased by 41.86%
B5-5000gauss	Decreased by 30.23%	Decreased by 20%
B10	Decreased by 28%	Decreased by 7%
B10-2000gauss	Decreased by 28%	Decreased by 16%
B10-5000gauss	Decreased by 50%	Decreased by 16%
B15	Decreased by 8%	Increased by 21%
B15-2000gauss	Decreased by 15%	Decreased by 10%
B15-5000gauss	Decreased by 18%	Decreased by 10%

Table 4: comparison of HC emission for all blends

NITRIC OXIDE (NO) EMISSION:

Two important parameters predominantly affect the formation of the NO emission in a CI engine. One is stoichiometry and the other one is in-cylinder temperature. The in-cylinder temperature has a strong effect on the formation of the NO emission. If the combustion temperature is higher, then higher NO emission is formed (8). Butanol blends will slightly decreases the NOX emission because of its high latent heat vaporization when compared to diesel. On application of magnetic induction NOX emissions are slightly increased because it enhances the combustion, which will increases the temperature in the engine.

IV. CONCLUSIONS

- The brake thermal efficiency of the blends increases on the application of fuel ionization technique.
- The specific fuel consumption of the blends decreases on the application of fuel ionization technique.
- The HC & CO emissions are decreased on using butanol but using of fuel ionization technique they were further decreased.
- The NOX emissions are not much effected on using fuel ionization technique.

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